INTERNET DOCUMENT INFORMATION FORM

A. Report Title: A Comparison of Air Force Organic Airlift and Commercial Air Express Distribution Performance

B. DATE Report Downloaded From the Internet: October 18,1999

C. Report's Point of Contact: (Name, Organization, Address, Office Symbol, & Ph #): DEPARTMENT OF THE AIR FORCE
AIR FORCE JOURNAL OF LOGISTICS
501 WARD STREET
GUNTER ANNEX
MAXWELL AFB, AL 36114-3236

D. Currently Applicable Classification Level: Unclassified

E. Distribution Statement A: Approved for Public Release

F. The foregoing information was compiled and provided by:
DTIC-OCA Initials: __pm__ **Preparation Date OCTOBER 18, 1999**

The foregoing information should exactly correspond to the Title, Report Number, and the Date on the accompanying report document. If there are mismatches, or other questions, contact the above OCA Representative for resolution.

A Comparison of Air Force Organic Airlift and Commercial Air Express Distribution Performance

Captain Travis Condon, USAF
William Cunningham, PhD
Major Kevin Moore, PhD, USAF
Captain Kirk Patterson, USAF

Introduction

With the end of the Cold War and the resulting decline in the military budget, the Department of Defense (DoD) must now rely on a logistics system capable of supporting a smaller, highly mobile and advanced-technology force with more flexible and responsive processes at a lower total cost. In response to this shift from the traditional mass logistics paradigm of holding large inventories, the 1996 edition of the DoD Logistics Strategic Plan highlighted the need for a restructured logistics system. The plan identified two desired outcomes of restructuring logistics: "... better, faster and more reliable and highly mobile response capability and a leaner infrastructure that better balances public/private capabilities."[1] To this, the Services and joint community responded with such programs as Lean Logistics, Total Asset Visibility, Velocity Management and Focused Logistics. Today, within the Air Force we see programs such as Agile Logistics and Agile Combat Support.

As military budgets declined, most of the initiatives to improve responsiveness and reduce total costs focused on reducing logistics delivery or pipeline times. The emphasis on reducing pipeline time is not unwarranted. A 1990 Air Force Logistics Command analysis indicates that a 1-day reduction in pipeline time could reduce inventory costs by $16M to $25M annually.[2] Another study indicates that a day of pipeline costs saved for all DoD customers translates into nearly $100M less in inventory stock the DoD must purchase.[3]

With fewer defense dollars, it is imperative the Air Force reduce overall logistics costs while maintaining appropriate levels of mission capability. Today, and for the foreseeable future, the Air Force has a widening range of choices in commercial transportation services to evaluate when managing military logistics and distribution processes. Significant improvements, most notably in information technology and global expansion over the last two decades, may allow commercial transportation carriers to provide faster delivery times at lower total cost. The aforementioned importance of reducing delivery times warrants more research concerning the benefits of using commercial transportation services for military cargo.

The main objective of this research is to determine if commercial express carriers have a significantly shorter total pipeline time than Air Force organic transportation systems. If commercial carriers are faster, the second objective is to ascertain which portions of the Air Force transportation pipeline cause delays when compared to the equivalent portions of the commercial carrier pipeline. To narrow the scope of the research, the study focuses on the airlift of high-priority cargo via commercial express and organic transportation from various supply points in the United States destined for Spangdahlem Air Base (AB), Germany.

Background

The Air Force uses the Uniform Materiel Movement and Issue Priority System (UMMIPS) to establish priorities and movement time standards for all cargo. The priorities defined and the time standards established apply to any given segment of the order and ship pipeline from the depot to base level. The time standards are in calendar days and represent the maximum amount of time that should elapse during any given pipeline segment for items that are in stock. Priority designators are determined from the Force/Activity Designator (FAD) code assigned to the requesting unit and the Urgency of Need Designator (UND) specified by the requester. Priority designators are consolidated into priority groups and time standards are given for each priority group in each segment of the pipeline.

Under UMMIPS, the oldest requisition within the highest priority group is put at the top of the priority list. Once the priority is established, DoD organizations have several options when deciding on the most appropriate mode of transportation to meet the UMMIPS time standards, maintain mission readiness and limit logistics costs. Military organizations located overseas have traditionally relied on the Air Mobility Command (AMC) to move priority cargo; however, commercial express carriers are now readily available to transport military cargo.

In addition to the priority of the cargo, the structure of the logistics pipeline itself has a major impact on delivery time. In the Air Force, a logistics pipeline is composed of many steps depending on the type of materiel being requisitioned, its source and destination. High-priority aircraft replacement parts generally originate from depots or Air Force bases and are airlifted via organic military airlift or express commercial airlift to a destination. Several organizations may get involved depending on the route of the materiel. The originating and terminating traffic management offices, supporting ground transportation and AMC aerial port organizations may contribute to the movement of the requisitioned item. If commercial airlift is used, the item may move from an origin location to a destination without any military organization involvement. A combination of AMC organic and commercial service is possible as well.

	MEAN	MEDIAN	MODE	STANDARD DEVIATION	VARIANCE	OBSERVATIONS
ORGANIC	6.86 ($\bar{x}_1$)	6	5	6.21 (s_1)	38.56 (σ_1^2)	545
FEDEX	2.77 ($\bar{x}_2$)	3	2	1.11 (s_2)	1.24 (σ_2^2)	144

Table 1. Total Transit Time[8]

Several major differences exist between AMC organic airlift and commercial airlift. Foremost, AMC airlift is centered around channel service. A channel is a regularly scheduled mission over a fixed route with capacity available to all customers. A monthly schedule is published for both passenger and cargo channel missions, and a priority system is used to allocate airlift resources where demand exceeds AMC capabilities.

In contrast to military organic transportation, express commercial carriers—such as Federal Express (FedEx), United Parcel Service, Airborne Express and Emery—are more responsive to customer demands and are able to adjust flight schedules and airlift capabilities on a daily basis if necessary. According to the Program Management Advisor for FedEx, they are able to fly an additional aircraft with only a few hours notice if necessary to ensure the on-time arrival of cargo.[4] Commercial express carriers have structured their business practices to ensure speedy, reliable and flexible delivery.

The capabilities of commercial express carriers have led some to believe airlift of high-priority cargo should be outsourced to the private sector to reduce logistics pipeline times, inventory levels and overall logistics costs. World Wide Express[5], the latest plan to outsource more airlift to express carriers, is expected to transfer approximately 40 percent of the cargo now being transported by AMC to commercial express carriers.

Data Collection

The primary source of data collection for organic transportation was the Air Force Traceability and Cargo (ATAC) system. Because of the scope and limitations of this study, the only data selected for analysis were high-priority cargo shipments identified by 777 and 999 priority codes destined for Spangdahlem AB. Five months of pipeline transit times were collected (1 December 1995 through 30 April 1996) for a total of 533 shipments. Transit times for engines, hazardous cargo and classified materiel were not analyzed since these items are not shipped via express carriers.

To make comparisons with organic transit times, commercial transit time information was needed. FedEx was chosen to represent commercial carriers because they transport the majority of commercially carried cargo bound for Spangdahlem AB.[6] Unfortunately, collecting this data proved to be difficult. The ATAC system could not provide adequate commercial data for the 5-month period. In an attempt to obtain data, FedEx was contacted, but they indicated they could not provide the information for the specific time period. Their system purges the data after 30-60 days and the test period was much older than 60 days from the date of request.[7] Instead, they provided shipment data for the month of February 1997 for 144 shipments. It was felt there were no significant differences between the two time periods that would invalidate the organic and commercial comparisons.

Results and Discussion

Using the data provided by FedEx and Air Force organic data, descriptive statistics were computed as shown in Table 1. In order to determine the possibility of outliers in the data, frequency distributions for FedEx and organic shipments were created. They are shown in Table 2.

Noting the significant variance attributed to the overall organic shipment times (Table 1) and dispersed frequency distribution in Table 2, a Box and Whisker Plot[9] and Stem and Leaf Plot[10] were used to determine any probable outliers for possible elimination from the statistical tests for both the organic and FedEx data. Based on the results of both plots, the data eliminated as probable outliers from organic shipment information were those in which total shipment time exceeded 20 days. The 11-day shipment time in the FedEx data was also considered an outlier and eliminated. The outliers for each set of data were eliminated because they were not regular occurrences and did not indicate a constant problem. After elimination of outliers from both sets of data, 97.8 percent of the original data and 99.3 percent of the FedEx data were still intact

# DAYS	FEDEX	%	CUMUL	ORGANIC	%	CUMUL
1	1	0.7	0.7	0	0.0	0.0
2	68	47.2	47.9	13	2.4	2.4
3	51	35.4	83.3	14	2.6	5.0
4	20	13.9	97.2	76	13.9	18.9
5	1	0.7	97.9	125	22.9	41.8
6	1	0.7	98.6	121	22.2	64.0
7	1	0.7	99.3	80	14.7	78.7
8			99.3	34	6.2	85.0
9			99.3	16	2.9	87.9
10			99.3	23	4.2	92.1
11	1	0.7	100.0	14	2.6	94.7
12				6	1.1	95.8
13				4	0.7	96.5
14				1	0.2	96.7
15				0	0.0	96.7
16				3	0.6	97.2
17				0	0.0	97.2
18				2	0.4	97.6
19				1	0.2	97.8
20				1	0.2	98.0
21				3	0.6	98.5
22				1	0.2	98.7
23				2	0.4	99.1
24				2	0.4	99.4
33				1	0.2	99.6
81				1	0.2	99.8
104				1	0.2	100.0
TOTAL	144	100.0		545	00.0	

Table 2. Frequency Distribution of FedEx and Organic Shipments

for statistical comparison. The derived descriptive statistics for the remaining data are shown in Table 3.

Statistical analysis using the standard z statistic[11] indicated a significant difference between the two mean delivery times at an alpha level of less than .01. A two-tailed test indicated the mean military pipeline time was significantly greater than that of FedEx. Total pipeline time for the military organic system was more than 3.5 days longer on average.

After determining there was a significant difference between Air Force organic and FedEx movement times, the next step was to determine which segments of the transportation pipeline exhibited differences between the two systems. The transportation pipeline segments for each system are shown in Table 4.

Table 5 shows the average times for each segment of the pipeline. Segment 1 was significantly longer for the organic transportation system (1.74 days) than for the commercial system (0.27 days). The comparison is between FedEx average transit time to move items from military supply depots to Memphis, Tennessee (MEM-FedEx hub) and the average transit time of carriers to transport items from the depots to Dover AFB, Delaware (the Air Force aerial port of embarkation [APOE] for this study).

According to an Air Force Materiel Command (AFMC) representative, an average of 1.74 days for this segment is not an unreasonable transit time for organic transportation.[12] After a Materiel Release Order (MRO) is issued at the depot, the transportation organization at the depot prepares the item for shipment and places it in a carrier's bin. A carrier's representative then arranges the cargo pickup for onward movement. This pickup could occur on the same day if the MRO was issued early enough in the day, which is often the case, since carriers schedule several pickups from the depots daily. When this happens, the item would be delivered the next day at Dover AFB—thus incurring a 1-day delivery period. However, if the MRO was released late in the day, the item would not be picked up until the following day. It would then be delivered to Dover on the second day after the MRO was issued—thus incurring a 2-day delivery period. Another consideration for this segment period is the inclusion of weekends. FedEx and other carriers do not deliver on weekends. An item picked up on Friday will not be delivered until Monday. This commercial practice obviously increases the average time for this segment. The AFMC depot ships the items as soon as possible after receiving the shipment notice without regard to flight schedules at the APOE.

One way to reduce this segment of the organic system entails releasing items for shipment at the depot so they could be picked up by the carrier that same day and delivered the next day. However, since this is only a time-accounting tactic, it would not affect the overall shipment time from the customer's perspective.

Segment 2 of the pipeline consists of the port hold and handling time at the APOE—the Dover AFB aerial port for the organic system and Memphis, Tennessee, for FedEx. This segment is also statistically longer for the organic system, taking about 2 days at Dover and about 4.5 hours at Memphis. AMC records confirm this finding. They indicate Dover's port hold time for high-priority items during 1996 was 48.5 hours. At that time, one C-5 and one KC-135 flew daily channel missions from Dover AFB to Ramstein AB, Germany, and the port received about 1,000 packages from express carriers daily. The small express packages, generally delivered by 12:30 p.m. to the port, were immediately in-processed and placed on pallets for loading on a KC-135 that departed at 4:45 p.m. However, large and outsized priority cargo could not be placed on a KC-135 because of the cargo hold size restrictions of the aircraft. These items, such as an F-15 wing, could wait 3-4 days in the port for space on a C-5 aircraft. Another problem that extends port hold time is the unreliability of the C-5. Too many times, cargo is delayed at the port simply because the aircraft breaks and cannot be transported until the aircraft is repaired. Beginning on 10 June 1997, the C-5 was replaced with the more reliable, yet smaller, C-17 to lessen this problem. Thus, the longer port hold time is in part due to the large items that FedEx refuses to carry, which must be stored at the APOE until space on a large military aircraft is available. One way to reduce this segment of the organic system would be to schedule both the KC-135 and the C-5 or C-17 after the FedEx delivery each day. Then, the high-priority items could be immediately placed on a departing aircraft that day.

Segment 3 consists of the comparison between the average flight time from Dover AFB to Ramstein AB and the average flight

	MEAN	MEDIAN	MODE	STANDARD DEVIATION	VARIANCE	OBSERVATIONS
ORGANIC	6.24 ($\bar{x}_1$)	6	5	2.39 (s_1)	5.72 (σ_1^2)	533
FEDEX	2.71($\bar{x}_2$)	3	2	.88 (s_2)	.77 (σ_2^2)	143

Table 3. Total Transit Time After Removal of Outliers

SEGMENT	1	2	3	4	5	TOTAL
ORGANIC	Depot ship to APOE Receipt	APOE Receipt to APOE Ship to APOD	APOE Ship to APOD Receipt	APOD Receipt to APOD Ship	APOD Ship to Final Receipt	Total Ship Time
FEDEX	Origination to Receipt at MEM Hub	MEM Receipt to MEM Ship to FRA	MEM Ship to FRA Receipt	FRA Receipt to FRA Ship	FRA Ship to Final Receipt	Total Ship Time

Table 4. Pipeline Segments

APOE: Aerial Port of Embarkation
APOD: Aerial Port of Debarkation
MEM: Memphis, Tennessee
FRA: Frankfurt, Germany

SEGMENT		1	2	3	4	5	Total
ORGANIC	MEAN	1.74	1.96	0.41	0.39	1.73	6.24
	STD	1.35	1.16	.90	0.51	1.71	2.39
	VAR	1.83	1.36	.81	0.26	2.94	5.72
FEDEX	MEAN	0.27	0.19	0.50	0.29	0.33	2.77
	STD	na	na	na	na	na	1.11
	VAR	na	na	na	na	na	1.24

Table 5. Computations for Total Pipeline and Segment Times (in days)[13]

time from Memphis to Frankfurt, Germany. Not surprisingly, there appears to be no significant difference in average flight time between the two systems.

Segment 4 is the port hold time at the aerial port of debarkation (APOD) for the military organic system and at Frankfurt for FedEx. For the organic system, port hold time begins when the aircraft officially lands (block time) and ends when the shipment is processed into the Consolidated Aerial Port System. For FedEx, it is the time between check-in of the package until release for movement to Spangdahlem AB. As in the case for segment three, there does not appear to be a significant difference between the two systems.

Segment 5 of the system is the transportation time between the APOD (Ramstein AB for the organic system and Frankfurt International Airport for the commercial system) and the Spangdahlem AB supply office. Once again, time for the organic system is significantly longer than it is for the commercial system. The cargo is trucked from the APOD to Spangdahlem for both systems. The drive is approximately 4 to 6 hours. The commercial system averages about 8 hours for this segment while the organic system averages about 1.73 days. For the organic system, the Army's 28th Transportation Battalion picks up a truckload every day from the aerial port and delivers the cargo to Spangdahlem.[14] One possible cause for the delay is when there is more than one truckload of cargo the excess may have to wait 1 or more days to be delivered to Spangdahlem. Another possible cause is when the cargo arrives after the truck departs for Spangdahlem. Thus, the cargo would wait 1 day for surface transportation. These two possibilities could combine to create the large average segment time seen. The obvious solution to this problem is to schedule the departure of the truck after aircraft have arrived and been downloaded. Additionally, if one truck cannot handle all of the Spangdahlem cargo, then arrangements for an additional truck should be made prior to arrival of the shipment.

Conclusion

The primary purpose of this research was to determine if commercial carriers deliver military cargo originating in the Continental United States to Spangdahlem AB, Germany, faster than the military's own organic pipeline. Since the total time was longer for military organic systems, the second objective was to determine which portions of the military's transportation pipeline cause the delay in delivery time. The primary conclusion drawn from this research is commercial carriers are, indeed, able to transport small items (weighing less than 150 pounds) to Spangdahlem AB faster than the military's traditional organic transportation system. A secondary conclusion taken from this research is that every segment of the pipeline, except the actual flight time between the US and Europe (Segment 3) and the port hold time (Segment 4), is longer for military organic transportation.

There are several other points made in this research. The first is that organic transportation is not the cause of longer organic pipeline time. When, as with the proposed World Wide Express system, the decision is made to substitute the commercial sector for organic logistical functions, it is not more efficient transportation that is being sought. Rather, when DoD utilizes FedEx, it is purchasing the logistics network and not simply transportation. Unfortunately, when one hears complaints voiced comparing AMC to the commercial sector, the impression is that transportation is the weak link.

The problem with making this assessment is that attention is misdirected from the actual problem and potential solutions. It is the network that is inefficient, and particular pipeline segments seem to be the culprit. Thus, prior to simply outsourcing or privatizing with commercial firms, research should be undertaken to see if the organic pipeline can be modified to achieve the desired level of service for less cost than FedEx. Some potential modifications were offered that require little or no cost, such as better coordination with the Army surface transportation at the destination. Another potential cause for increased organic pipeline time may be the result of how the organic shipment is recorded as being delivered. If shipment delivery information is entered into the system in a batch mode at the destination, then depending on when the shipment arrived and when the information is entered into the computer, a discrepancy of several days could exist. If the item arrived on a Friday afternoon but was not recorded until Monday, an extra 3 days would be indicated on the official record. This does not happen with FedEx or other commercial carriers because they require a signature prior to releasing their shipment, and the time of the signature determines their official recorded delivery time. In reality, there may be one or two *phantom* days in the organic pipeline delivery time. Requiring organically delivered items to be recorded upon receipt is a costless way to decrease both the mean delivery time and variance, assuming this situation exists.

Better coordination between AMC and the Army, in terms of trucks and capacity needed at the destination, as well as when they are needed, would seem to be a relatively free improvement or one with little cost. The same may be true of coordination between AMC and the depots. Although the depot metrics may appear better if the depot ships as soon as an item is ready, if this is not coordinated with AMC flight schedules, then there is no real benefit to the customer, and it makes another pipeline segment time appear longer. Thus,

while the metrics for the depot may improve and customer service levels appear to be higher, there is no benefit to DoD or the customer.

This article is hopefully a first step in the process of improving the AMC channel system. In any improvement process for a system that is comprised of multiple segments or functions, an essential first task is to identify those segments where problems seem to exist and where the system appears to be functioning efficiently. While the *quick fix* in the short term may be the outsourcing of transportation, in the long term it may be more efficient to redesign the organic network to better reflect post-Cold War logistics needs, particularly if a major part of the redesign simply requires better coordination between the various segments and entities involved.

Notes

1. *Logistics Strategic Plan,* ODUSD(L)MDM, Washington DC, 22 Jun 96.
2. Hill, John, Frederick Rexroad and Roger Moulder, *Effects of Changes in Order and Ship Times and Depot Repair Cycle Times on Aircraft Availability and Procurement Costs,* XPS Technical Report #89-348, Wright-Patterson AFB OH: Directorate, Management Sciences, July 1990.
3. General Accounting Office, *Best Management Practices: Reengineering the Air Force's Logistics System Can Yield Substantial Savings,* GAO Report GAO/NSIAD-96-5, Washington DC: GPO, February 1996.
4. Endres, Bill, Program Management Advisor, Government, Federal Express Corporation, Greenbelt MD, Telephone interview, 3 Mar 97.
5. World Wide Express is a government-contracted small package delivery service. The contract was awarded July 1998 and service began 1 October 1998. The contract is for international express delivery of packages weighing less than 150 pounds.
6. Bass, Lori, Weapon System Support, Headquarters Air Force Materiel Command AFMC/LGTW, Wright-Patterson AFB OH, Personal interview, 25 Apr 97.
7. Endres, Bill, Telephone interview.
8. Because FedEx does not deliver on Saturday or Sunday, weekends were not included in transit time calculations. In order to accurately account for total shipment time from the customer's perspective, the appropriate number of days were added to each shipment total delivery time when weekends were involved.
9. A Whisker Plot, also called a box plot, is simply the division of the data into quarters. Each quarter of the data is represented on a graph with an x axis for perspective. The top 25 percent and lower 25 percent are shown with lines; the middle 50 percent is displayed with a box divided at the 50th percentile.
10. A Stem and Leaf Plot is similar to a relative frequency histogram, but contains more information. The stem is the left-most common digit of the data, whereas the leaf is the remainder of the data. Stem and Leaf Plots display actual data in a table format in order from smallest to largest, with all data points with like stems listed in the same row of the table with a line dividing the stems and leaves.
11. A z statistic is a mathematical comparison of the data, with assumptions of normality (a bell-shaped curve), consistent variation of the data within each data group and similar variations between data groups. If the assumptions are met, then the data can be compared. If the data groups are close enough mathematically, then the data are said to not be significantly different. If the data groups are different enough mathematically, then the data are said to be significantly different. Hence, conclusions can be made about data groups and whether or not they are the same or different mathematically, with the alpha level simply being how accurate the test is. An alpha level of 0.01 simply means an accuracy of 99 percent in the solution. Also, two-tailed tests look at how different the data groups are by determining if the data groups are different either by one group being greater than the other or vice versa. A one-tailed test simply looks at one side; for example, if group A is greater than group B, but not if group B is larger than group A, whereas a two-tailed test will look at both possibilities.
12. Figueroa, Andy, Air Force Materiel Command Transportation Combat Readiness Branch Chief, Personal interview.
13. The sum of the averaged segment times for FedEx is less than the overall shipment time data because the averages do not include weekends.
14. Little, Phillip D., Chief, Cargo Movements, 52d Transportation Squadron, (TRNS/LGTT), Spangdahlem AB GE, Telephone conversation, 4 Aug 97.

Captain Travis Condon is currently Chief of European and Southeast Asia Plans at Headquarter Air Mobility Command, Scott AFB, Illinois. Dr. William A. Cunningham is a Department Head in the Graduate School of Logistics Management at the Air Force Institute of Technology. Major Kevin Moore is an Assistant Professor in the Graduate School of Logistics Management at the Air Force Institute of Technology. Captain Kirk Patterson is the Command Transportation Management Inspector at Headquarters Air Mobility Command, Scott AFB, Illinois.

Aircraft Airworthiness Symbols and Mission Capable Codes

Carroll Herring

In the day-to-day business of keeping Air Force aircraft flying safely while still meeting mission requirements, the two key management controls are airworthiness symbols and mission capability codes. Several recent aircraft accidents have increased management concern about the use of these symbols and codes. The Air Force cannot afford any confusion on the part of the mechanic or aircrew about which symbol to use. The maintenance documentation must carefully reflect an aircraft's airworthiness. A single error or omission can be disastrous.

Aircraft Airworthiness Symbols

The key to accurate identification of an aircraft's airworthiness is a thorough understanding of the three status symbols used in maintenance documentation as defined by *Technical Order 00-20-1.* Red symbols are used for immediate attention and instant recognition. The actual symbol is based on technical data, the nature of the discrepancy (what is broken, what needs inspection, etc.) and the judgment of the maintenance crew or aircrew. Symbols consist of a Red X, meaning the aircraft is considered unsafe or unfit for flight; a Red Dash, indicating an unknown condition; and a Red Diagonal, meaning an unsatisfactory but airworthy condition. If a Red X is assigned, the aircraft is not to be flown until the unsatisfactory condition is corrected and the symbol is cleared. Special authorization procedures are used to downgrade an aircraft for a one-time flight under tightly controlled conditions with specific restrictions for normal flight operation. Not just anyone can *clear* a Red X—an individual must be on a special certification roster to be granted this authority. Normally, a mechanic must be certified to a 7 skill-level or higher to be on the certification roster. Each major command (MAJCOM) defines specific certification criteria for its mechanics. Next to the Red X, the most serious symbol is the Red Dash. The Red Dash indicates a more serious condition *may* exist. Conditions can include the need for required inspections, accessory replacements, operational check, functional check or necessary maintenance. The third and least

(Continued on top of page 40)